U.S. Department
of Transportation
Federal Aviation
Administration

# Advisory Circular

**Subject:** DRAFT - Turbine Engine Continued Rotation and Rotor Locking

**Date:** DRAFT
Initiated By:

**AC No:** DRAFT
33.74/92-1A
**Change:**

**1. PURPOSE**. This advisory circular (AC) provides guidance and acceptable methods, but not the only methods, that may be used to demonstrate compliance with the continued rotation and rotor locking requirements of the Federal Aviation Regulations, under part 33 of Title 14 of the Code of Federal Regulations (14 CFR part 33). This AC is combining §§ 33.74 and 33.92. This AC may be incorporated into AC 33.2, Aircraft Type Certification Handbook at a later date.

**2. RELATED CFR SECTIONS**.

a. Part 33 - Airworthiness Standards: Aircraft Engines; §§ 33.74 and 33.92.

b. Part 29 - Airworthiness Standards: Transport Category Rotorcraft; § 29.903(c).

c. Part 25 - Airworthiness Standards: Transport Category Airplanes; § 25.903(c).

d. Part 23 - Airworthiness Standards: Normal, Utility, and Acrobatic Category Airplanes; § 23.903(e)(2).

**3. BACKGROUND**. On June 4, 1996, The FAA published Amendment 17 to part 33 that updated and modernized the technical requirements applicable to the type certification of aircraft engines. A new regulation addressing continued rotation and windmilling was incorporated to be consistent with the safety objective of similar airplane requirements found in §§ 23.903(e)(2) and 25.903(c). Existing § 33.92 was revised to remove an outdated windmilling requirement for supersonic engines and to clarify the existing rotor locking test requirement language. The guidance in this AC supersedes the windmilling and rotor locking portions of AC 33.2B, paragraph 63, Windmilling Tests.

**4. DEFINITIONS**. The following are defined for the purpose of this AC.

a. Continued rotation. A condition where there is rotation of any engine main rotating system in an engine that has been shut down. Continued rotation can be caused by windmilling or mechanical effects, or a combination of both. Windmilling is rotation of a non-operating engine due to the airflow induced forces on the blades caused by the forward motion of the aircraft. Certain mechanical effects can also result in the continued rotation of a non-operating engine. An example of this includes the drive shaft clutch drag in some multi engine rotorcraft installations, which may result in continued rotation of the engine after it has been shut down.

b. Rotor Locking Device. A mechanical device which will prohibit rotation of the engine rotor(s) when the engine is shut down.

**5. CONTINUED ROTATION**. The safety objective of § 33.74 is to ensure that an engine that continues to rotate after shut down will not create a hazard to the aircraft. Implied within this objective is a design requirement that precludes generally non-hazardous engine basic failure conditions or events from developing into a hazardous event over a sustained continued rotation period. Compliance to this requirement can be



**This document does not represent final agency action on this matter and should not be viewed as a guarantee that any final action will follow in this or any other form.**

by test, analysis, or any method determined to be acceptable to the Administrator, and should represent the typical aircraft installation for that engine.

a. Applicability. The requirements of § 33.74 apply to turbine engines installed in aircraft and rotorcraft.

b. Failure and operating conditions. Conditions that should be considered and addressed if determined to be applicable should include, but are not limited to, items (1) through (6) of this subparagraph. Consideration should be given to extended periods of continued rotation within the one engine inoperative flight envelope following these failure conditions:

(1) complete loss of engine oil supply (quantity or pressure);

(2) engine rotor airfoil loss and resulting effects;

(3) basic non-hazardous IFSD (e.g., fuel starvation);

(4) loss of rotor centerline support (e.g., main bearing failure; fusing of frangible main bearing designs);

(5) in supersonic to subsonic transition flight conditions (if applicable), and

(6) in supersonic flight conditions (if applicable).

Engine basic failures or events not generally under consideration include main rotor structure failures (e.g., disks, spacers, seals & shafts), unless those failures are considered non-hazardous and will likely result in continued rotation of the engine. Failure of a rotor locking device is also not generally considered under § 33.74. Also, there is no intent to consider airframe structure failures (e.g., slat/flap ingestion); or airframe foreign object sources (e.g., lavatory ice or wing/radome ice ingestion), which are beyond the scope of



**This document does not represent final agency action on this matter and should not be viewed as a guarantee that any final action will follow in this or any other form.**

part 33 certification. Lastly, there is no intent to judge the effects of continued rotation on the installation.

c. Hazard criteria. An engine that continues to rotate after shut down, and which results in any condition identified in § 33.75(a) through (c), is considered a hazard to the aircraft. These hazardous conditions are (1) catch fire, (2) burst (release hazardous fragments through the engine case), and (3) generate loads greater then those ultimate loads specified in

§ 33.23(a).

d. Installation assessment. The applicant should make a thorough assessment of the flight conditions expected to occur during continued rotation operations and consider but are not limited to, the following:

(7) The maximum exposure time for continued rotation for an individual event, and for the life of an engine. This determination should not be based on the probability of occurrence as a function of flight phase. Also, this assessment should consider special operations such as ETOPS/EROPS.

(8) Turbine rotor(s) rotational speeds given expected aircraft flight profiles.

(9) Unbalance levels as applicable.

e. Fire hazard. Of special importance during extended continued

rotation periods is protection against fire. For example, rotor windmill speeds coupled with high imbalance levels can produce high stress levels at sub-idle natural frequencies. Another possible consequence of a windmill unbalance condition is "rubbing" of titanium



**This document does not represent final agency action on this matter and should not be viewed as a guarantee that any final action will follow in this or any other form.**

rotor and stator components. The applicant should assess the design against these concerns.

**6. ROTOR LOCKING**. The engine manufacturer has the option to incorporate a rotor locking device into the type design of the engine in order to comply with the safety objective defined in

§ 33.74. Activation of the device will stop and prevent subsequent continued rotation of the engine rotor(s) during flight when the engine is not operating. The device is part of the engine type design and should be subjected to the same test criteria as other components in the engine. In addition, the rotor locking device should satisfy the operational and endurance test requirements identified in § 33.92 while the engine is subjected to the environmental conditions that result in the maximum rotational torque. The assessment of the maximum rotational torque should consider both damaged and undamaged engine rotors.

a. Reliability. The use of a rotor locking devise is expected to be infrequent, therefore, it should be shown that under normal engine operating conditions the device will not deteriorate beyond serviceable limits such that it fails to perform the intended function.

b. Design criteria.

(1) The rotor locking device should be designed in such a manner that it is possible for the flight crew to unlock the engine rotor(s) in order to initiate engine restart attempts. In the event these attempts are unsuccessful, it should be possible for the flight crew to relock the engine rotor(s).



**This document does not represent final agency action on this matter and should not be viewed as a guarantee that any final action will follow in this or any other form.**

(2) The effect on continued safe flight and landing in the event of an uncommanded activation of the rotor locking device in flight should be considered. In addition,
consideration should be given to the single failure and engine isolation provisions of the appropriate aircraft CFR's.

(3) Environmental effects on rotor locking device performance should be evaluated for the engine operating envelope.

**END**



**This document does not represent final agency action on this matter and should not be viewed as a guarantee that any final action will follow in this or any other form.**